

4.1: Grading the Molecular Models for Cellular Respiration Worksheet

*This worksheet has “grading” in the title because at this point, students can be held accountable for correct answers. Level 4 (correct) responses to the questions are in **blue bold italics** below. Red italics suggest ways to grade student responses by giving them points for correct or partially correct answers. There are 14 points total on this worksheet.*

A. Introduction

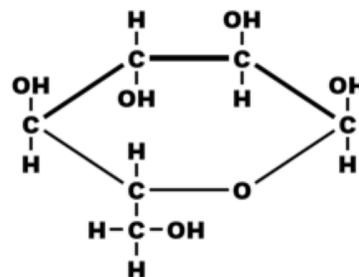
The cells of animals, plants, and decomposers all use chemical energy stored in glucose and other organic molecules by combining them with oxygen (O_2). This chemical change, called cellular respiration, releases energy stored in the molecules’ high-energy C-C and C-H bonds.

Think about the unanswered questions from your investigation and class discussions that you have had. *When the atoms in the glucose and oxygen molecules are rearranged during cellular respiration, what molecules are formed? What forms of energy does the chemical energy change into?*

B. Using molecular models to show the chemical change

Work with your partner to make models of the reactant molecules: glucose and oxygen. Glucose—a kind of sugar—is a carbohydrate. Using twist ties, show how chemical energy is stored in the high-energy bonds of glucose and other organic molecules.

- Make models of a glucose molecule ($C_6H_{12}O_6$) and oxygen molecules (O_2 , with a double bond). Cells use oxygen during cellular respiration, so make 6 O_2 molecules. Put these molecules on the *reactant* side of the *Molecular Models Placemat*.
- Use twist ties to represent chemical energy. Put a twist tie around **each** high-energy bond (C-C and C-H bonds) in the glucose molecule. Put the “Chemical Energy” card under the glucose molecule to label the energy in the C-C and C-H bonds. Note how many energy units (twist ties) there are in the glucose molecule.



Show how the atoms of the reactant molecules can recombine into product molecules—carbon dioxide and water—and show how chemical energy is released when this happens.

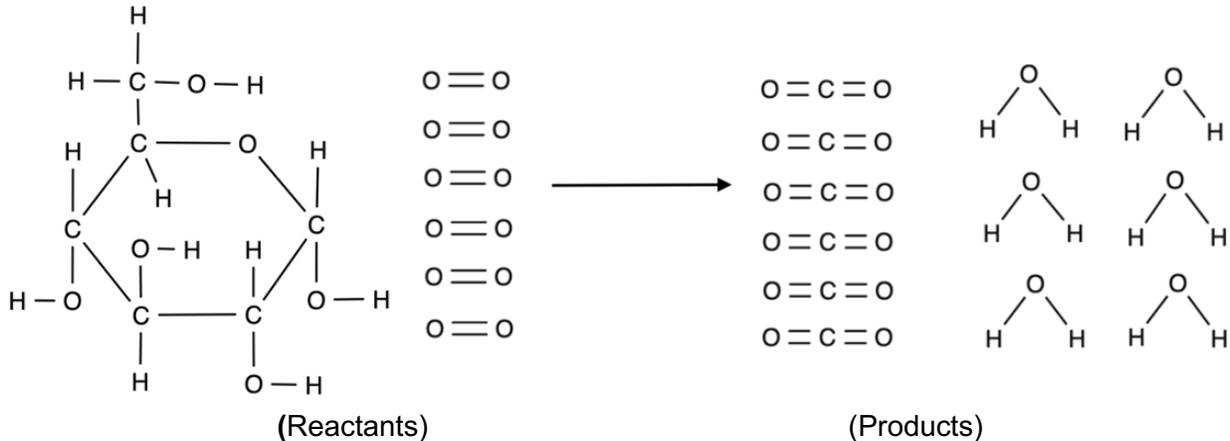
- Take the glucose and some of the oxygen molecules apart and recombine them into carbon dioxide (CO_2) and water (H_2O) molecules. Put these molecules on the *product* side of the *Molecular Models Placemat*. Some things to notice:
 - How many oxygen molecules reacted with one glucose molecule? **6**
 - How many carbon dioxide molecules were produced? **6**
 - How many water molecules were produced? **6**
- Energy lasts forever, so move the twist ties to the *product* side of the *Molecular Models Placemat*. Carbon dioxide and water have only low-energy bonds (C-O and H-O), so what forms does the chemical energy change into? Put the correct energy cards under the twist ties.

C. Atoms last forever!

Account for all the atoms in your models.

1 point for each correct answer

6 points total



1. Circle all of the Carbon ATOMS in the reactants. How many are there? **6**
2. Circle all of the Carbon ATOMS in the products. How many are there? **6**
3. Underline all of the Hydrogen ATOMS in the reactants. How many are there? **12**
4. Underline all of the Hydrogen ATOMS in the products. How many are there? **12**
5. Put a square around all of the Oxygen ATOMS in the reactants. How many are there? **18**
6. Put a square around all of the Oxygen ATOMS in the products. How many are there? **18**

D. Energy lasts forever!

Account for all the energy in your models.

1 point for each correct answer

4 points total

1. How many twist ties are there before the chemical change? **12**
2. What form of energy is there before the chemical change? **Chemical energy**
3. How many twist ties are there after the chemical change? **12**
4. What form of energy is there after the chemical change? **Motion and heat energy**

E. Check Yourself!

1 point for each correct answer

3 points total

1. Did the number and type of atoms stay the same at the beginning and end of the chemical change? **Yes**
2. Did the number of twist ties (representing energy) stay the same at the beginning and end of the chemical change? **Yes**
3. Why do the numbers of atoms and twist ties have to stay the same? **Matter and Energy last forever (in living systems)!**

F. Writing the chemical equation

Use the molecular formulas ($C_6H_{12}O_6$, O_2 , CO_2 , H_2O) and the yield sign (\rightarrow) to write a balanced chemical equation for the reaction:



1 point for correct chemical equation